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ABSTRACT

To implement metric education in Pennsylvania's vocational curriculum, the following objectives were planned: (1) establish two pilot metric measurement sites; (2) reproduce 150 copies of the 55 metric measurement booklets developed by the National Center for Research in Vocational Education (NCRVE); (3) orient vocational administrators to the curricular implications of metrics and to the administrative support needed for implementation; (4) provide information to teacher educators on metrics and the strategy for the modification of curriculum; (5) prepare trainers who can offer workshops at the local level in the state; (6) conduct local workshops to prepare teachers to use the NCRVE metric materials; and (7) prepare students to use metric measuring devices and terminology in their trade areas. Some of the major outcomes of the project include the following: two metric measurement pilot sites were successfully started and a model program for other vocational schools was adopted; a total of 109 facilitators were successfully trained to teach metric measurement to the vocational teachers; local facilitators successfully trained over 1,200 vocational teachers on how to teach metric measurement to their students; the vocational teachers gave metric measurement instruction to over 17,000 vocational students; and over 7,000 students were able to master the metric measurement material to a level of 80% or better. Further, it is projected that by 1981 the 44 vocational schools and 18 correctional institutions that received funds for metric education will have given instruction to over 30,000 vocational students. (BM)

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Implementation of METRIC MEASUREMENT Into the Vocational Curriculum of Pennsylvania

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1979

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PREFACE

The future of vocational education rests with the implementation of programs that match technological development in business and industry. Today one of the most important developments in our industrial society is the changeover from the English system of measurement to the metric system. The challenge for vocational education is to prepare students to gain a working knowledge in both the English and metric systems so they can meet the demands of business and industry.

To meet this challenge, the Pennsylvania Research Coordinating Unit for Vocational Education designed a plan for implementing metrics into the vocational curriculums and assigned staff and funds to support the activities. The results of this effort are reported in detail in this publication.

In general, the overall results were very encouraging. However, the RCU feels that this effort is just a start in preparing vocational students for the world of work. In fact, this effort is considered a stopgap measure until the elementary and middle schools make metrics the first "language" of measurement.

We solicit suggestions and comments on this publication and offer our help to those initiating or implementing worthwhile metric measurement activity.

Carroll A. Curtis

Carroll A. Curtis, Director
Pennsylvania RCU for
Vocational Education

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The RCU expresses its appreciation to all individuals, agencies and institutions that contributed to this project.

We especially thank John Gomolak, Central Westmoreland AVTS; Joseph J. Kach, Lehigh County AVTS; and all of their support staff for an excellent job of training the local trainer facilitators. We also would like to thank the Vocational Education Information Network staff for coordinating some of the metric workshops and duplicating metric instructional materials. Finally, we extend our appreciation to all vocational directors, trainer facilitators, classroom teachers and students for an outstanding job of carrying out the metric measurement plan for Pennsylvania.

SUMMARY

The purpose of this report was to describe how the Pennsylvania Research Coordinating Unit exemplary funds were used to meet the metric measurement needs of vocational students. From April 1977 to January 1979 over $170,000 of federal exemplary funds were used to establish pilot metric measurement sites, purchase metric software and hardware, train local facilitators in metric measurement, train teachers on how to teach metrics and teach vocational students how to use metrics in their areas of study.

The major outcomes of the implementation of metric measurement in the vocational schools of Pennsylvania were the following:

1. Two metric measurement pilot sites were successfully started and a model program for other vocational schools was adopted.

2. Copies of the 55 metric measurement booklets that were developed by the National Center for Research in Vocational Education, Ohio State University, were distributed to schools that participated in the project.

3. A total of 109 local facilitators were successfully trained to teach metric measurement to the vocational teachers.

4. Local facilitators successfully trained over 1,200 vocational teachers on how to teach metric measurement to their students.

5. The vocational teachers gave metric measurement instruction to over 17,000 vocational students.

6. Over 7,000 students were able to master the metric measurement material to a level of 80 percent or better.

7. Nonpublic vocational schools were invited to participate in the metric measurement activities.

8. It is projected by 1981 the 44 vocational schools and 18 correctional institutions that received funds for metrics will have given instruction to over 30,000 vocational students.

INTRODUCTION

Industrialized nations are becoming increasingly dependent upon world trade for economic survival. Differences in measurement systems, even among metric countries, caused sufficient problems in world trade that during the 1960's an international conference was held to develop a worldwide system of measurement. The old metric system was updated and simplified to a metric system called the International System of Units (SI). Even though SI is fast, easy to use and much like our monetary system, the United States is the last major industrial nation in the world to adopt the SI metric system.

Many U.S. companies have already changed to metric-sized products in order to trade with other countries. Pharmaceutical companies changed most of their products to metrics about 20 years ago. Companies which make automobiles and trucks, earth-moving and agriculture equipment, business machines and machine tools have also been converting to metrics. The U.S. metric planning committees for paint and lumber and wood products recommended changing to metric sizes in 1978-79, the same time Canada makes the change. The nine European economic community countries will require that all products imported after 1978 be labeled in metric or produced and labeled in metric sizes.

There are many U.S. workers using the metric system or are learning on the job: designers and draft persons, tool and die makers, machine tool operators, assemblers, inspectors, office personnel, advertising and sales workers, and shipping and receiving clerks. Many new labor contracts stipulate that the company supply the metric tools workers need. In 1975 Congress established a metric education office in the Office of Education and approved spending up to $10 million each year until 1978 to help prepare teachers and students to use the SI metric system.

At least 32 states plan to change to the metric system in their schools. In September 1974 the Pennsylvania State Board of Education established regulations providing the instruction in the metric system of measurement (See Appendix A). In 1976 California, Oregon, Texas and Arizona required that new textbooks contain mostly metric measurement. California requires that (1) the metric system become the "primary system" of measurement taught and used in the schools; (2) by 1979-80 it is to be the "first language" of measurement for grades K-6; and (3) by 1980-81 only metric measurement will be used in their schools. Many other states have similar plans.

Sensing that a "snowball effect" was taking place worldwide as well as in the United States with the metric changeover, the National Center for Research in Vocational Education, Ohio State University, obtained a grant from the federal Bureau of Occupational and Adult Education to produce metric instructional materials for vocational education in the United States. After two years of development, the NCRVE produced 55 individual job-related instructional booklets. All of the materials were prepared with the help of experienced vocational teachers, reviewed by experts, tested in classrooms in different parts of the United States and revised before distribution to insure proper usage of the materials. In addition, the NCRVE developed an in-service model for each state to follow.

Carroll A. Curtis, director of the Pennsylvania Research Coordinating Unit, felt that the metric materials and in-service model developed by the NCRVE would be beneficial for the vocational schools of Pennsylvania. In the fall of 1976 he prepared a metric measurement implementation plan for the vocational schools that was approved by the Pennsylvania Department of Education and is included in the Pennsylvania State Plan for Vocational Education (See Appendix B).

OBJECTIVES

Specifically, the implementation strategy was directed toward the following objectives:

1. Establish two pilot metric measurement sites.
2. Reproduce 150 copies of the 55 metric measurement booklets developed by NCRVE.
3. Orient vocational administrators to the curricular implications of metrics and to the administrative support needed for implementation.
4. Provide information to teacher educators on metrics and the strategy for the modification of curriculum.
5. Prepare trainers who can offer workshops at the local level in Pennsylvania.
6. Conduct local workshops to prepare teachers to use the NCRVE metric materials.
7. Prepare students to use metric measuring devices and terminology in their trade areas.

PROCEDURES

The procedures for implementing the objectives were to:

- establish pilot metric measurement sites;
- reproduce metric software;
- orient vocational administrators and teacher educators;
- award exemplary funds for metric measurement projects;
- train teacher facilitators to give metric workshops;
- in-service teachers on metric measurement;
- prepare students in metric measurement; and
- measure the results of the implementation efforts.

Timetable

January 1977	-	Design implementation plan
March 1977	-	USOE regional workshop
April 1977 to December 1978	-	Solicit applications
April 1977 to September 1978	-	Orientation for vocational administrators and teacher educators
June 1977	-	Contract for reproducing metric software
July 1977 and 1978	-	Teacher trainer workshop
August 1977 to June 1979	-	Local in-service programs
September 1977 to June 1979	-	Classroom metrics offered
March 1979	-	1976-77 and 1977-78 Metric impact report

RESULTS OF THE PLAN FOR IMPLEMENTATION OF METRICS INTO THE VOCATIONAL CURRICULUM

Metric Measurement Pilot Test Sites

The first step of the plan was to pilot test the metric measurement materials developed by the NCRVE. At two-day in-service workshops held at Central Westmoreland AVTS and Lehigh County AVTS in the spring of 1977, 50 vocational teachers and 10 administrators received training in metric measurement. The program focused on providing the participants a working knowledge of the metric system in relationship to individual vocational education program areas. Various types of metric software and hardware were tested; and recommendations were made for diffusion across the state.

Metric Software Production

Delaware County I.U. #25 was awarded a contract to reproduce 150 copies of the 55 metric measurement booklets developed by the NCRVE. The booklets were distributed to schools that participated in the metric workshops for local facilitators.

Orientation for Vocational Administrators and Teacher Educators

Invitation letters for participating in the metric measurement program were sent to all of the secondary and postsecondary vocational directors, directors of education for the 18 youth and adult state correctional institutions and vocational department heads of each teacher education institution. The administrators who wanted to participate were sent the Teacher In-Service Workshop for Metric Proposal and a cover letter (See Appendix C). Follow-up telephone calls were made to administrators who did not respond. In addition, announcements about the metric program were made at the Vocational Administrators of Pennsylvania meetings.

A number of administrators indicated that they were already involved in metric programs with local colleges. It should be noted that the Philadelphia School District did not participate in the metric program because it was a pilot site for the NCRVE metric program. All of the Philadelphia vocational teachers were given in-service training by the NCRVE program or the local metric workshops.

By December 1978 all vocational schools and correctional institutions were contacted or involved in a metrics program.

1977 Metric Workshop for Local Facilitators

During the summer of 1977, VEIN held two in-service workshops to give local failitators the necessary background to teach the metric system to local vocational teachers. The VEIN staff, coordinated by Evelyn Werner, managed workshop activities. Gloria Cooper, Metric Measurement Project Director, NCRVE, and Robert Klingler, Curriculum Coordinator, Delaware County AVTS, were the consultants. The RCU evaluated the workshop.

The total of 65 local facilitators from area vocational-technical schools, community colleges and teacher education institutions participated in the two-day training workshops at the Central Westmoreland AVTS and Millersville State College. Process and product evaluation instruments were used to determine the effectiveness of the project's objectives. The process instrument used was the Metric Workshop Evaluation developed by the Pennsylvania RCU. This instrument collects data on the facilitators' views toward the organization, facilities, presenters, course materials and films. The second part assesses the participant level of competencies in five metric measurement areas of instruction. The Metric Measurement Test developed by the RCU measures facilitator's knowledge of metric measurement. The items are based on the five units of instruction developed by the NCRVE, Ohio State University (See Appendix D for copies of the evaluation instruments).

Table I reports the results of the metric workshop evaluation. The data shows that 90 percent of the items on question 1, "How would you rate the following?", received "excellent" to "good" ratings. "Quality of presentations" received highest overall rating. There are only four "poor" or "unsatisfactory" ratings on the seven items for question 1.

In regards to question 2, "What is your level of competencies?", the data shows that over 80 percent of facilitators rated themselves "high" to "average" attainment in the five competencies listed. It should be noted that 18 percent of the facilitators stated that they attained a low-level competency with metrics in their occupation or program.

The results of question 3, "Do you feel the training you received adequately prepared you to conduct a metric workshop?", shows that 54 facilitators (84 percent) said "yes." The last question, "Do you feel adequately prepared to help teachers develop lesson plans in metric measurement?", received a similar response. A total of 56 facilitators (87 percent) said they were adequately prepared.

Table II shows that 29 facilitators (45 percent) correctly answered 48 of the 60 items on the Metric Measurement Test. A total of 48 facilitators, or 80 percent, correctly answered 42 of the 60 items. The average score was 42 and the most frequent score was 52. The range of scores was from 31 to 59 and the standard deviation was 6.69.

TABLE I

1977 Metric Workshop Evaluation

1. How would you rate the following?	Excellent		Good		Fair		Poor		Unsatis-factory		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Organization of the workshop	31	(47)	29	(45)	4	(6)	1	(2)	0	(0)	65	(100)
Adequacy of facilities	41	(64)	18	(28)	4	(6)	1	(2)	0	(0)	64	(100)
Quality of presentations	28	(43)	32	(49)	4	(6)	0	(0)	1	(2)	65	(100)
Adequacy of course materials	21	(32)	38	(59)	6	(9)	0	(0)	0	(0)	65	(100)
Adequacy of hands-on devices	31	(48)	27	(41)	6	(9)	1	(2)	0	(0)	65	(100)
Quality of films	32	(49)	26	(40)	7	(11)	0	(0)	0	(0)	65	(100)
Adequacy of course content to my needs	25	(39)	32	(49)	8	(12)	0	(0)	0	(0)	65	(100)

2. What is your level of competency?	High		Average		Low		Total	
	N	%	N	%	N	%	N	%
In working with linear, area, temperature, mass and volume.	27	(42)	33	(52)	4	(6)	64	(100)
With metric in your occupation or program.	39	(62)	21	(33)	3	(5)	63	(100)
In metric-metric equivalents.	35	(54)	26	(40)	4	(6)	65	(100)
In selecting and using metric tools and devices.	35	(56)	26	(42)	1	(2)	62	(100)
In working with metric conversion tables, ordering, selling and using products and supplies.	28	(44)	34	(54)	1	(2)	63	(100)

3. Do you feel the training you received adequately prepared you to conduct a metric workshop?	Yes		No		Total	
	N	%	N	%	N	%
	54	(84)	10	(16)	64	(100)

4. Do you feel adequately prepared to help teachers develop lesson plans in metric development?	Yes		No		Total	
	N	%	N	%	N	%
	56	(87)	8	(13)	64	(100)

TABLE II

Local Facilitators' Results on the
Metric Measurement Test for the 1977 Workshop

Number of Facilitators	65
Total Possible Score on the Metric Test	60
Average Score	47
Most Frequent Score	52
Range of Scores	31 to 59
Number that Correctly Answered Over 80%	29
Number that Correctly Answered Over 70%	48
Standard Deviation	6.69

1978 Metric Workshop for Local Facilitators

During the summer of 1978, the RCU sponsored two in-service workshops to give local facilitators the necessary background to teach the metric system to local vocational teachers.

A total of 44 local facilitators from AVTSs, community colleges, correctional institutions and teacher education institutions participated in the two-day training workshops at the Central Westmoreland AVTS and Lehigh County AVTS. The Metric Workshop Evaluation and Metric Measurement Test were used to determine the effectiveness of the workshop.

Table III reports the results of the 1978 metric workshop for local trainers. The data shows that almost 90 percent of the participants felt the "organization of the workshop" and "adequacy of facilities" were "excellent." Almost all the participants considered the "quality of presentations" and "adequacy of course content" as "excellent" or "good." About three-fourths of the participants rated "adequacy of course materials" and "adequacy of hands-on devices" as "excellent." It should be noted that there were no "poor" or "unsatisfactory" ratings given by the participants.

In regards to question 2, "What is your level of competency?", positive levels of competencies were indicated by "high" ratings for "working with linear, area, temperature, mass and volume." "Working with metrics" was the second highest level of competency reported. A majority of the ratings was "high" (64 percent) for the competency dealing with "selecting and using metric tools and devices" and 50 percent with "metric in your occupation or program." Fifty-five percent of the participants felt that they achieved only "average" or "low" when "working with metric conversion tables, ordering, selling and using products and supplies." The reason for these scores seemed to be insufficient time to master the competency.

The results of question 3, "Do you feel the training you received adequately prepared you to conduct a metric workshop?", show that 95 percent said "yes." The last question, "Do you feel adequately prepared to help teachers develop lesson plans in metric measurement?", also shows that 95 percent said "yes."

TABLE III

1974 Metric Workshop Evaluation

How would you rate the following?	Excellent N	%	Good N	%	Fair N	%	Poor N	%	Unsatis-factory N	%	Total N	%
ganization of the rkshop	39	(89)	5	(11)							44	(100)
equacy of facilities	39	(89)	5	(11)							44	(100)
ality of presen-tions	24	(54)	18	(41)	2	(5)					44	(100)
equacy of course terials	33	(75)	10	(23)	1	(2)					44	(100)
equacy of hands-on vices	34	(77)	10	(23)							44	(100)
ality of films	29	(66)	12	(27)	3	(7)					44	(100)
equacy of course ntent to my needs	22	(50)	19	(43)	3	(7)					44	(100)

What is your level of competency	High N	%	Average N	%	Low N	%	Total N	%
working with linear, area, temperature, ss and volume.	32	(73)	12	(27)			44	(100)
h metric in your occupation or program.	22	(51)	19	(44)	2	(5)	43	(100)
metric-metric equivalents.	27	(62)	16	(36)	1	(2)	44	(100)
selecting and using metric tools and ices.	24	(54)	17	(39)	3	(7)	44	(100)
working with metric conversion tables, lering, selling and using products and plies.	20	(46)	19	(43)	5	(11)	44	(100)

Do you feel the training you received adequately prepared you to conduct a metric workshop?	Yes N	%	No N	%	Total N	%
	42	(95)	2	(5)	44	(100)

Do you feel adequately prepared to help teachers develop lesson plans in metric development?	Yes N	%	No N	%	Total N	%
	42	(95)	2	(5)	44	(100)

Table IV gives the results of a t-test analysis of scores on the Metric Measurement Test, which measures the facilitator's knowledge of metric measurement in terms of linear, area, volume, mass and temperature. The MMT was administered to the 44 facilitators before and after the metric measurement workshop. The results indicate a t-score of 8.33, which is significant beyond the .01 level.

TABLE IV

Pre-Post Comparison of Scores on the Metric Measurement Test

N	Pre-test Mean	Post-test Mean	t-score
44	39.64	52.16	8.33*

*Significant beyond the .01 level.

Description of the 1977-78 Metric Workshop for Local Facilitators

This course is designed to prepare vocational secondary, post-secondary and special education teacher facilitators to meet the job-related metric measurement needs of students. Facilitators were exposed to the five units of instruction developed by the NCRVE, Ohio State University. The units contain performance objectives, learning activities and supportive information in the form of text, exercises and tables. The workshops also feature a number of teaching strategies and hands-on experiences with metric tools and equipment.

The competencies designed for the workshop were:

Competency A - given metric tools and equipment, complete five metric instructional units to the satisfaction of the instructor (See Appendix E).

Competency B - given metric tools and equipment, prepare a lesson plan for a specific student population and a metric measurement task to the satisfaction of the instructor.

This means of developing competencies:

Competency A - Unit I, a general introduction to the metric system of measurement, provides informal, hands-on experiences for the participant. This unit enables participants to become familiar with the basic metric units, their symbols and measurement instruments and to develop a set of mental references for mental values. A metric system of notation is also explained.

Unit II provides metric terms which are used in the occupation and give practical experiences with occupational measurement.

Unit III focuses on job-related metric equivalents and their relationships.

Unit IV provides experiences for recognizing and using metric instruments and tools in occupational measurement tasks. It also provides experiences in comparing metric and customary measurement instruments.

Unit V is designed to give participants practice in converting customary and metric measurements. Participants should learn to think metric and avoid comparing customary and metric units; however, skill with conversion tables will be useful during the transition to metric in each occupation.

Competency B

- Secure approval for lesson plan topic.
- Gather necessary tools, equipment and materials to prepare a lesson plan.
- Prepare a lesson plan that incorporates the following components:

  1. breakdown of student population
  2. length of time
  3. performance objective
  4. methods
  5. learning activity
  6. resources
  7. evaluation

- Present the prepared lesson plan to the group.

Classroom experiences with this instructional package suggest the following teaching/learning strategies:

1. The first experience should be informal so as to make learning the metric system fun.

2. Participants learn better when metric units are compared to familiar objects. Everyone should learn to think metric. Comparing metric units to customary units can be confusing.

3. Participants will learn quickly to estimate a measure in metric units by doing.

4. Participants should have experience with measuring activities before getting too much information.

5. Move through the units in an order which emphasizes the simplicity of the metric system.

6. Teach one concept at a time to avoid overwhelming students with too much material.

Local Vocational School Metric Measurement Program

During fiscal years 1976-77, 1977-78 and 1978-79, 44 vocational schools received grants from the RCU to provide instructional staff in-service training in metric measurement and to teach metrics to the student (See Appendix F). Project funds were used to purchase metric measurement devices, metric library materials and workshop consultants.

A total of $172,166 in federal funds was used for the metric projects. Close to the same amount was matched by local funds by the participating vocational schools. To be eligible for funding, the vocational schools agreed to provide 10 instructional hours for students in metrics and two individuals to work as facilitators and to release the facilitators for two days to attend one of the summer metric measurement workshops for local facilitators (See Appendix C).

The vocational schools conducted metric measurement workshops in much the same way as the workshops for the trainer facilitators. The local trainees held two-day workshops, or 10 hours of instruction, throughout the school year for vocational teachers and administrators. Vocational teaching staff from nonpublic schools in the area were invited to the workshops and were given a set of metric instructional materials. The metric hardware was made available to them as a loan.

An important part of the local school metric program was to give metric measurement instruction to the students. The NCRVE metric measurement package, pages 1 through 12, was the primary material used. In addition, teachers prepared lesson plans on various aspects of metrics for a specific program (See Appendix G).

TABLE V

Funding for Metric Measurement Projects

Fiscal Year	Type of Project	Local Funds	Federal Funds
1976-77	Pilot Metric Program	$ 2,895	$ 24,190
1976-77	Workshops for Local Facilitators	$ 2,100	$ 20,623
1976-77	Printing of Metric Materials	0	$ 4,232
1976-77	Local Metric Workshops	$ 93,609	$ 54,983
1977-78	Local Metric Workshops	$ 4,198	$ 13,526
1978-79	Workshops for Local Facilitators	0	$ 28,889
1978-79	Local Metric Workshops	$ 37,489	$ 24,919
Totals	Pilot Metric Program	$ 2,895	$ 24,190
	Workshop for Local Facilitators	$ 2,100	$ 49,512
	Printing of Metric Materials	0	$ 4,232
	Local Metric Workshops	$135,296	$ 93,428
Grand Total		$140,291	$171,362

Local Vocational School Metric Measurement Projects

The following are the results of the local vocational schools' metric measurement projects. The Metric Measurement Survey was used to collect the data (See Appendix H). Table VI shows the results for schools that were funded during fiscal years 1976-77 and 1977-78. It should be noted that three schools did not report the impact data of their metric measurement project. The results for the 1978-79 projects will be reported in the fall of 1979.

The data shows that of the 1,241 teachers in the 30 vocational schools for fiscal years 1976-77 and 1977-78, 1,014, or 81 percent, received in-service training in metric measurement. The table also shows that approximately 40,000 students were enrolled in the vocational schools that participated. Approximately 43 percent of the students (17,965) received metric instruction. It should be noted that the data, collected from June 1977 to December 1978, does not reflect the impact of the project on the nonpublic schools or the impact after the metric survey was returned to the RCJ.

An important finding of the results was the number of students who successfully answered at least 80 percent of the questions on the individual program metric test. Table VI shows that 39 percent of the 7,043 students reached the 80 percent level or higher. The reason why only 7,043 of the 17,965 students who received instruction took the test is the fact that only 55 vocational program tests were developed by the NCRVE. Pennsylvania has over 200 vocational program offerings.

To measure the impact of students enrolled in programs where no metric test was available, a number of schools developed a comparative test (See Appendix H).

TABLE VI

Summary of Teachers and Students Receiving Metric Measurement Instruction During Fiscal 1976-77 and 1977-78

umber of Teachers in Your School	Number of Teachers Inserviced on Metric Measurement	Number of Students in Your Vocational Program	Number of Students Receiving Metric Instruction		Number Who Successfully Answered At Least 80% of Questions	
			N	%	N	%
1,241	1,014	41,401	17,965	43.30	7,043	39.20

Plans and Projections for 1979-80

Indiana State University received a grant from the RCU to give in-service to trainer facilitators for the nine state correctional institutions and the nine youth development centers. Over 40 trainers will attend a two-day metric measurement workshop at the Central Westmoreland AVTS in February 1979. Each institution will receive a set of metric measurement booklets developed by the NCRVE and have additional consultative services available from Indiana State University.

The 15 vocational schools funded for the 1978-79 fiscal year are presently conducting metric workshops and instructing students. Data will be collected from these institutions in June 1980. It is projected that over 400 vocational teachers and 6,000 vocational students will be exposed and reach an acceptable level of competency in metric measurement for these areas of study. It is also projected that by 1981 the 44 vocational schools and the 18 correctional institutions that received grants for implementing metric measurement will have given instruction to over 30,000 vocational students. It is estimated that about 60 percent of these students will reach a level of competency of 80 percent or above in their various areas of study.

Appendix A
Suggested Guidelines for the Selection of Metric Instructional and Learning Aids

On September 13, 1974 the State Board of Education established regulations providing for instruction in the metric system of measurement:

Regulations

5.52 Metric System (For the Elementary School)

The concepts of measurement shall be taught using the units of the metric and English systems co-equally in the activities of science and mathematics in each school year as part of the planned courses of these subjects as appropriate. Such instruction shall be included in the learning activities of all subjects and be designed to develop skills for the use of the metric system in everyday life.

5.77 Metric System (For the Secondary School)

The concepts of measurement in all subjects shall be taught emphasizing the use of the metric system and referring to the English system only as special requirements demand its use. Specialized courses such as science and mathematics shall utilize whatever measuring system is consistent with the specialized measuring activities of the discipline. Instruction in measurement shall be concerned with those measurement skills and units used in everyday life, except for specialized courses where extensive measuring activities are required, and shall be concerned with the understanding and use of the system of measurement.

This action of the State Board of Education was in response to the increased national tendency to adopt the metric system as the nation's primary system of measurement.

Another response to this national trend toward metrication has been the proliferation of commercially-produced learning materials and instructional aids in the form of equipment, materials, supplies and kits. This increase in new materials has prompted the Pennsylvania Department of Education to develop criteria to assist school districts in evaluating and selecting instructional aids for metric materials.

All instructional and learning aids should be carefully examined to determine how they satisfy the following suggested criteria:

1. Purpose: Is the aid appropriately designed to do what it is claimed that it will do? Is it designed only for teacher demonstrations or is it usable for both teacher and student use?

2. Versatility: Is the aid usable for a variety of purposes or for a single purpose? Versatility in use is very desirable. Is it portable and easy to use?

3. Quality: Are the aids sturdily constructed? Are the related supplies of a quality to be effectively used in the operation of the aid and/or in the total instructional program? Is the cost appropriate?

4. Precision: Is the aid constructed with enough precision to function properly? Will the aid measure with sufficient precision for a particular measurement? Is the precision suitable when considering the maturity and achievement level of the students?

5. Size: Are all critical parts of sufficient size to be readily visible? Are the controls and scales easily read?

6. Physical Science: Is the device sturdily constructed? Are there relatively weak or fragile parts? Are there parts which may become misplaced? Will it withstand student use and possibly abuse? Are replacement parts readily available?

7. Safety: Does the device contain potential hazards to students or teachers such as moving parts, sharp corners, heating elements? Are all electrical parts properly grounded to eliminate shock hazards?

8. SI Units: Does the aid or materials use the International System of Units (SI)? Are definitions of units, style, spelling and their form consistent with the guide published by the National Bureau of Standards?*

9. Achievement and Maturation Level: Are the materials or aids suitable for the achievement level and maturity of the students for which they are intended?

10. Sequential Development: Does the design of the aid include sequential development of measuring concepts? Example: (a) comparison between objects; (b) comparison of objects with nonstandard units; (c) comparison of objects to be measured with SI units; (d) estimation; and (e) selection of measurement units suitable for specific tasks.

11. Activity Orientation: Do the aids lend themselves to an activity-oriented approach? Do they present student exercises that are designed to develop functional skills employing those SI units which are actually used in everyday experiences?

12. Conversion: Are conversions between SI units and English units minimal? Conversions between the two systems should be avoided whenever possible.

13. Cost: How does the cost of the material being considered for purchase compare with the cost of other sets of materials designed to do the same task? What will be the cost of maintenance? Does it have a shelf life? What will be its life in moderace use?

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*NBS, SP 330, 1974 edition, The International System of Units (SI), Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, Price: 65¢ (Order SD Catalog No. C 13.10:330/30).

Appendix B

Plan for Implementation of Metrics into the Vocational Curriculum

Goal

The goal of this proposed activity is to assume the leadership at the state level to have metrics introduced into the vocational curriculum in a timely and systematic manner.

Need

After many years of debate, in December 1975, with the signing of the Metrics Conversion Act, the United States became the last major nation in the world to move toward metrics as an international standard of measure. In actuality, many trades in this country are, and have been, using metrics for some time--though not without some difficulty where the measuring systems interface.

Background

According to the State Department of Commerce, over 100 foreign firms have established plants in Pennsylvania employing more than 20,000 workers with an excess of $200 million/year payroll. To further facilitate participation in international trade, workers must understand and be able to use both metrics and the present system of measurement in order to repair, service and remodel new and existing investments.

In anticipation of the Metrics Conversion Act, the U.S. Office of Education has made a considerable investment over the last several years in the development of metrics programs for 55 program areas in vocational education. The National Center for Research in Vocational Education at the Ohio State University has been responsbile for the development of these materials.

During the 1975-76 school year, the program was field tested nationwide with reportedly encouraging results. Stanley Cohen from Philadelphia, the only field test site in Pennsylvania, was enthusiastic about the program. Other indications lead us to believe that these materials may be the best and most complete available.

As part of the USOE dissemination strategy, a complete set of materials will be provided to either the Research Coordinating Unit or the Vocational Education Information Network and a workshop will be held in Philadelphia by OSU staff for Region III states. It is estimated that attendance for Pennsylvania participants may be limited to about 25 individuals.

Two AVTSs in Pennsylvania will pilot the implementation of these materials during 1976-77 under the guidance of the RCU and with the support of exemplary funds. These schools are the Central Westmoreland AVTS and the Lehigh County AVTS. These two sites will give us experience with implementation and can, if necessary, serve as cores for diffusion.

This plan proposes a strategy to make possible implementation of the OSU metric materials into all AVTSs in Pennsylvania by June 1979 in a simple, inexpensive manner. This will require a series of training as well as information sessions as outlined below. The program should be self-sustaining and require no program expenditures after that time. If left to their own devices, it is feared that efforts to gain metric competence will result in fragmented, inadequate coverage.

Objectives

Specifically, the implementation strategy will be directed toward the following objectives:

- Prepare trainers in Pennsylvania who can offer workshops at the local level.
- Provide information to teacher educators on metrics and the strategy for curriculum modification.
- Orient vocational administrators on curricular implications of metrics and administrative support needed for implementation.
- Local workshops for teachers to prepare them to use OSU metric materials.
- Classroom instruction with students to prepare them to use metric measuring devices and terminology in their trade area.

Source of Trainers

For an implementation effort of this magnitude, a cadre of trainers must be available. According to Gloria Cooper, consultant, National Center for Research in Vocational Education, 20 teachers per trainer would be a maximum, meaning two-to-four trainers required per workshop. These will become available from the following sources:

1. Participants from USOE Workshop
   a. Research Coordinating Unit
   b. Vocational Education Information Network
   c. Local Curriculum Coordinators
   d. Bureau of Vocational Education, Regional Staff
2. Local Pilot Sites
   a. Central Westmoreland AVTS
   b. Lehigh County AVTS
3. Special Training Program
   a. Local Curriculum Coordinators who are approved for implementation activities
   b. State Staff
   c. Special Project Staff (if needed for implementation)
   d. Teacher Educators
4. College Staff Presently Offering Nonvocational Workshops in Metrics

Informational Workshops for Teacher Educators

It is recommended that part of the implementation strategy be a series of three workshops held specifically for vocational teacher educators. These workshops would be for one day each and be of an informational nature including how policy is formed, measures determined and the assumptions made in the impending conversion.

These workshops could best be offered by Gloria Cooper and staff from the National Center for Research in Vocational Education, Ohio State University, who conducted the project for USOE, developed the materials and worked with the regulatory agencies.

Workshops conducted at the three major universities, inviting other vocational teacher educators at their own expense, would provide excellent coverage for a minimum of expenditure. The only direct costs would be for Gloria Cooper and staff.

Special Training Programs

It is proposed that one additional training program to prepare local curriculum coordinators as trainers and to oversee activities at the local level would be necessary. This program could be offered at the Central Westmoreland AVTS, one of the pilot schools during the 1976-77 school year.

Metric measuring devices are readily available at this school as well as its being a desirable location. This would reduce the travel and improve the opportunity for local educators from western Pennsylvania since the USOE-sponsored workshop is in Philadelphia and attendance is limited. Approximately 20 schools could be accommodated for training as trainers. The vocational director, William Downs, has already indicated the availability of the Central Westmoreland AVTS for this purpose.

This workshop could be presented by Gloria Cooper assisted by the RCU and/or VEIN.

Orientation for Vocational Administrators

An information session should be held for vocational administrators to prepare them for encouraging and supporting implementation of metrics within their schools. This workshop would not necessarily precede commitment by the director to have the school participate in implementation; however, it should occur at least concurrently.

It is suggested that an effort be made to obtain a couple of hours at the Annual VAP Conference to effectively utilize time administrators already are together. Presentations could be made by VEIN and/or RCU staff with no additional direct costs.

Local District Implementation Workshops

To implement the OSU metrics program, a school at a minimum must have available:

- two days of teacher in-service time for training; and
- a minimum of 10 hours of classroom time to work with students using metric units.

It is proposed that an agreement be drafted by the RCU within the following parameters with which AVTSs may apply to become part of the implementation effort during the 1977-78 school year.

The local district must agree to provide from local resources (if applicable):

- 10 classroom contact hours for students with metrics;
- two days of in-service time for each teacher;
- designate two individuals at local level to work as trainers and resource persons with teachers; and
- two days for which designated individuals may be released for training.

Project funds will provide:

- costs of training two local resource persons;
- costs of library materials ($500);
- costs of curriculum materials for each teacher ($12.50);
- costs up to $1,000 for metric measuring devices (negotiable);
- trainers needed in addition to two local consultants to provide workshop for local teachers; and
- film for local workshop.

Funding would be awarded to the number of schools agreeing to criteria that can be scheduled within resources available. It is estimated that 25 to 30 could be sponsored.

Funding

Funding of all activities listed in this paper could be supported by exemplary funds assuring substantive implementation of activities already found to be successful under field conditions.

Administration

This system could be supported with numerous individual proposals directed to the RCU by each agency involved or an agency such as VEIN could be selected to be the primary mover in setting up the program scheduling consultants, etc. Another alternative would be to design a combination of the above. The mechanics will be worked out with Erma Keyes, VEIN, and BVE staff.

Timetable

January 1977	Design Implementation Plan
February 1977	Solicit Applications
March 1977	USOE Regional Workshop
October 1977	Vocational Administrator Training
September-October 1977	Teacher Educator Training
August-October 1977	Teacher Trainer Workshop
October 1977-January 1978	Local In-Service Programs
January-June 1978	Classroom Metrics Offered

Appendix C

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF EDUCATION
BOX 911, HARRISBURG, PA. 17126

January 16, 1978

Mr. Robert Rowland
Director of Vocational Education
Huntingdon County AVTS
Box E
Mill Creek, PA 17060

Dear Mr. Rowland:

Over the past year the RCU has been actively installing metric measurement materials developed by the Center for Vocational Education, Ohio State University, in over 40 vocational schools. The response by the participating schools has been very encouraging. We would like to continue and expand this program for other interested schools.

Briefly, our metric program includes the following components:

1. The RCU, in cooperation with Lehigh County and Central Westmoreland AVTS, will provide regional workshops in July 1978 to train representatives from vocational schools to implement the Center for Vocational Education's metric program. The representatives will be trained to plan local workshops, provide assistance to teachers during implementation and collect data for reporting impact of the project.

2. The RCU will provide funds for metric measuring devices, metric library materials and workshop consultants as required for installing the metric materials into the classroom. The RCU will also provide funds for lodging, travel, subsistence and $75.00 a day stipend for representatives attending the two-day workshop.

The commitment from the schools are:

1. Submit a pre-prepared proposal to the RCU.

2. Send one representative (for every 30 teachers) to one of the two-day workshops.

3. Provide a two-day, in-service workshop for vocational teachers to orient them to the metric program.

4. Provide a minimum of 10 hours of instruction in the classroom for students in the various vocational programs. Students should be able to obtain an acceptable level of performance in the use of metric measurements in their respective occupational area.

5. Prepare a brief final report specifying the impact of the project for the teachers and students (the RCU will assist in this report).

If you are interested in this program, the RCU will send all the details to you. Please complete the attached form.

Sincerely,

James P. Lewis

James P. Lewis, Research Associate
Research Coordinating Unit

JPL/vf4

Attachment

R.C.U. Metric Measurement Program Survey

Institution _____

Director _____

Would you or one of your staff like to participate in a metric measurement program during the 1978-79 school year? Yes _____ No _____

If no, please indicate why _____

_____

If yes, which workshop would be convenient:

_____ Location: Central Westmoreland County AVTS
Arona Road, R.D. #1
New Stanton, PA 15672

Time: July 27, 1978 (9:30 a.m. - 4:30 p.m.) -
July 28, 1978 (9:00 a.m. - 3:30 p.m.)

_____ Location: Lehigh County AVTS
2300 Main Street
Schnecksville, PA 18078

Time: July 13, 1978 (9:30 a.m. - 4:30 p.m.) -
July 14, 1978 (9:00 a.m. - 3:30 p.m.)

Please indicate the name of the person that will be attending the workshop

_____.

Please reply within one month to:

Mr. James Lewis
Research Coordinating Unit
Bureau of Vocational Education
Pennsylvania Department of Education
Box 911
Harrisburg, PA 17126

JL/ct10

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF EDUCATION
BOX 911, HARRISBURG, PA. 17126

Thank you for responding to the RCU Metric Measurement Program Survey. In order to participate in the summer metric workshop for local facilitators and to obtain exemplary funds to conduct a local metric in-service program, the following should be done before May 1, 1978.

1. Fill in all of the appropriate blanks on the enclosed proposal.

2. Complete the detailed budget.

   Teachers. This is a local expense. The total number of teachers expected to be inserviced times the pay rate and number of days.

   Consultants. You may use additional consultants if you feel the local facilitators need more help in conducting the workshop for the teachers. The maximum for consultants is $150 per day for two days.

   Materials.

Reference Materials	$ 500 maximum
Metric Measuring Devices	$1,000 maximum
Office Supplies	$ 150 maximum

   Communications.

Telephone	$ 25 maximum
Postage	$ 25 maximum

3. Submit five copies of the completed proposal, standard contract, maintenance of effort form and the DEBE-131 application form to the regional office.

4. Complete all the forms for the summer metric workshop that will be sent to you by one of the coordinators.

All questions and details pertaining to the summer workshop for local facilitators should be directed to:

Mr. John Gomolak
Central Westmoreland AVTS
Arona Road, R.D. #1
New Stanton, PA 15672
(412) 925-3532

or

Mr. Joseph Kach
Lehigh AVTS
2300 Main Street
Schnecksville, PA 18078
(215) 799-1359

All questions and details pertaining to submitting the proposal and conducting the local metric in-service workshop should be directed to the RCU at (717) 787-4865.

Sincerely,

James P. Lewis, Research Associate
Research Coordinating Unit

JPL/dlr

Enclosures

PROPOSAL

Title: "Teacher In-Service Workshop for Metric Measurement"

Applicant/ Address: _____

Beginning and Ending Dates: July 1, 1978 through June 30, 1979

Proposed Funds:

Abstract: The objectives of this proposal will be to provide a two-day metric measurement in-service workshop for vocational teachers; develop metric instructional packages for each vocational program and provide 10 hours of classroom instruction to assist students in obtaining an acceptable level of performance in metric measurement.

Problem: A basic problem facing vocational educators is how to effectively teach metric measurement to students enrolled in different vocational programs. The need for metric training is already considered critical in machine shop, auto mechanics, material handling, drafting and sheet metal areas.

Objectives:

1. Provide a two-day in-service workshop for vocational teachers to orient them to metrics, acquaint them with the Ohio State metric materials and provide training on using metrics in the classroom.

2. Teachers will facilitate student instruction through the use of developed instructional packages peculiar to their program area.

3. Students will be able to obtain an acceptable level of performance in the use of metric measuring devices and conversion methods.

Contribution: The aim of this project is to provide the teaching staff with a working knowledge of the metric system as it applies to their individual laboratory through the use of a metric instructional package developed by The Center for Vocational Education at Ohio State.

Procedures: In response to a solicited request from the Pennsylvania Research Coordinating Unit, our vocational school has requested participation in a statewide implementation of the metric materials developed by The Center for Vocational Education at Ohio State.

To facilitate the implementation and to assist with the in-service workshop, a staff person(s) has been identified to provide leadership at the local level. This person(s) will: (1) be made available for training; (2) plan the local workshop; (3) provide assistance to teachers during implementation; and (4) collect data for reporting impact of the project.

Two in-service days will be provided for the in-service programs; and teachers will be advised that a minimum of 10 hours in the classroom will be required during the year to use these materials.

Project funds are requested to provide metric measuring devices, metric library materials and workshop consultants as required for installing the metric materials into the curriculum.

The project will be administered by the vocational director or a designee who will supervise the activities; maintain accounts; keep a descriptive and statistical account of the success of the implementation process; and submit a report of the success of this effort at the conclusion of the school year.

Dissemination: The implementation process and the materials developed will be available to other educational institutions. The results will also be disseminated through the Pennsylvania RCU and the Vocational Education Information Network at Millersville State College.

Personnel: The program will operate with trained consultant(s) that have expertise in both the metric system and the use of developed instructional packages peculiar to all program areas and be able to instruct, assist and guide the teaching staff.

Facilities: The existing facilities at the vocational school will be used for the purpose of this program.

Evaluation: The Pennsylvania RCU will prepare an evaluation design to measure both process and product accomplishments.

Accommodation of Students in Nonprofit Private Schools: This program will be made available to accommodate a total of _____ students in nonprofit private schools within the boundaries of this educational agency.

BUDGET

	Local	Federal	Total
Teachers			
___ for ___ day(s) @ ____ per day	_____	_____	_____
Consultants			
___ for ___ day(s) @ ____ per day	_____	_____	_____
Materials			
Reference Materials	_____	_____	_____
Metric Measuring Devices	_____	_____	_____
Office Supplies	_____	_____	_____
Communication			
Telephone	_____	_____	_____
Postage	_____	_____	_____
TOTAL	_____	_____	_____

SUGGESTED METRIC MEASUREMENT DEVICES

There is no single list of measuring devices that must be acquired by a school for the teaching of common units in the metric system. The following list is given for your consideration only. The items listed were selected from reliable suppliers and are readily available.

The following items will provide a teacher with the devices needed for completing the activities and exercises of objective one. Items marked with an asterisk (*) are optional and may be substituted by using another device. For example, a measuring tape attached to a wall can be used in place of a height measure.

Quantities are suggested for a class of 20 to 25 students. Here are some additional tips that may be helpful:

- Plan well in advance and consider all aspects of the use of the equipment.
- Look for metric equipment that is already in the school. Check with the math and science departments.
- Consider letting students design and construct some of the items. Also the advisability of converting old equipment for interim use.
- Stretch your budget. Prices differ among companies. Sometimes a local store is your best source. Multi-purpose items of good quality are worth considering.
- Improvise, where feasible, to save money and often to improve the learning experience.

Activity	Quantity	Measurement Device	Supplier	Catalog Number	Price**
Linear	10-12	Metre Stick	Blick	88006	3.15 ea.
			Brodhead	191009	2.73 ea.
			Ohaus	80010	2.95 ea.
	10-12	Rule, 30 cm	Blick	88029	3.60 pkg. of 10
			Ohaus	80080	.45 ea.
	10-12	Measuring Tape, 150 cm	Blick	88225	3.40 pkg. of 10
			Ohaus	80110	5.00 pkg. of 10
	1	*Height Measure	Blick	88039	14.80 ea.
	1	*Floor Stand for 88039	Blick	88040	11.90 ea.
	1	*Metre Tape, 10 metre	Blick	88013	7.90 ea.
			Ohaus	80130	9.95 ea.
	1	Metre Tape, 50 metre	Ohaus	80150	34.95 ea.
	1	Trundle Wheel	Blick	88042	10.80 ea.
			Ohaus	80190	10.95 ea.
	1	*Area Measuring Grid Transparent 25 cm x 25 cm Graph Paper, cm squares	Blick	88168	1.10 ea.

Activity	Quantity	Measurement Device	Supplier	Catalog Number	Price**
Volume/Capacity	1	*Nesting Measures, Set of 5, 50 ml - 1000 ml	Blick	88131	6.60 ea.
			Ohaus	80230	9.95 ea.
	1	Economy Breaker, Set of 6, 50 ml - 1000 ml	Ohaus	80240	2.95 ea.
	1	Metric Spoon, Set of 5, 1 ml - 25 ml	Ohaus	80350	.75 ea.
	1	Dry Measure, Set of 3, 50, 125, 250 ml	Ohaus	80340	1.50 ea.
	1	Cubic Litre	Blick	88134	2.60
			Ohaus	80320	3.50
	1	Centimetre Cubes, Interlocking Set of 100	Ohaus	4263-00	3.50
Mass	1	Personal Scale, Bathroom Type, Kilogram Scale	Blick	88110	12.40 ea.
			Ohaus	80440	14.50 ea.
	1	Platform Spring Scale, 5 kg Capacity	Ohaus	80430	12.50 ea.
		10 kg Capacity	Blick	88108	14.90 ea.
	1	Balance Scale with 8-Piece Mass Set	Ohaus	1200-00	25.00 ea.
	1	Spring Scale, 6 kg	Blick	88099	2.40 ea.
Temperature	1	Dipping Thermometer	Blick	88204	5.90 ea.
	2 - 3	Aluminum Backed Thermometer	Ohaus	80530	9.80 pkg. of 10

*Optional.

**Prices are subject to change.

Suppliers:

Brodhead-Garrett Company
4560 East 71st Street
Cleveland, OH 44105
(216) 341-0248

Dick Blick Company
P.O. Box 1267
Galesburg, IL 61401
(309) 343-6181

Ohaus Scale Corporation
29 Hanover Road
Florham Park, NJ 07932
(201) 377-9000

These national suppliers have regional offices throughout the United States. Many of the items may also be purchased from local school supply sources.

Imprinted metre sticks with your choice of wording (school name, think metric, etc.) may be ordered in a minimum quantity of 250 for approximately $.22 each from:

Anthony and Company, Inc.
P.O. Box 887
Escanaba, MI 49829
(906) 786-7573

SOURCES OF METRIC INFORMATION

Following is a directory of reliable sources of metric conversion information.

General

American National Metric Council
1625 Massachusetts Avenue, N.W.
Washington, D.C. 20036

American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018

Metric Association, Inc.
Sugarloaf Star Route
Boulder, CO 80302

Metric Information Office
National Bureau of Standards
Washington, D.C. 20234

Technical and Trade Associations

Air-Conditioning and Refrigeration Institute
1815 North Fort Myer Drive
Arlington, VA 22209

American Paper Institute
260 Madison Avenue
New York, NY 10016

American Society for Abrasive Methods
1049 South Main Street
Plymouth, MI 48170

The American Society of Mechanical Engineers
345 East 47th St.
New York, NY 10017

American Society for Metals
Metals Park, OH 44073

American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

American Welding Society
2501 Northwest 7th St.
Miami, FL 33125

Illuminating Engineering Society
345 East 47th St.
New York, NY 10017

Industrial Fasteners Institute
1717 South 9th St.
1505 East Ohio Bldg.
Cleveland, OH 44114

Institute of Electrical and Electronic Engineers
345 East 47th St.
New York, NY 10017

National Association of Manufacturers
277 Park Avenue
New York, NY 10017

National Fluid Power Association
P.O. Box 49
Thiensville, WI 53092

National Forest Products Association
1619 Massachusetts Avenue, NW
Washington, D.C. 20036

National Microfilm Association
8728 Colesville Road
Suite 1101
Silver Springs, MD 20910

National Tool, Die & Precision Machining Association
9300 Livingston Road
Washington, DC 20022

Society of Automotive Engineers
Two Pennsylvania Plaza
New York, NY 10001

Steel Plate Fabricators Association
15 Spinning Wheel Road
Hinsdale, IL 60521

Journals

School Shop, Vol. 23, No. 8, April, 1974

Scoring: Each correct answer is worth one point. Total possible score = 60

Name _____

METRIC MEASUREMENT TEST (Answer Key)

1. Please match the measuring units on the left with the use statements on the right.

Unit		Statement
a.	degree Celsius	f. flow through a pipe
b.	gram	g. building lot
c.	micrometre	b. food portions
d.	kilometre	h. body size
e.	watt	a. room temperature
f.	litres per second	m. energy required to pump water
g.	hectare	i. vehicle load limit
h.	centimetre	j. fertilizer application
i.	metric ton	c. surface finishes
j.	grams per square metre	d. hauling distance
k.	newton metre	k. tightening spark plugs
l.	square metre	l. warehouse storage space
m.	joule	e. rating of a motor
n.	litre	n. fuel tank

2. Which sentence is correctly typed?

a. The hand cleaner is 178 gs.
(b) The mass of the package is 28 g.
c. The paper is 216mm x 281 mm.
d. The car traveled 80 k/hour.

3. A 45° fillet weld 2 centimetres wide also has a width of:

(a.) 20 millimetres b. 2 millimetres c. 0.2 millemetre d. 200 millimetres

4. Please match the metric replacement on the left with the following units on the right.

a.	kilojoule	c. feet
b.	litre	e. fluid ounce
c.	metre	g. pound
d.	kilopascal	d. pounds per square inch
e.	millilitre	b. gallon
f.	kilowatt	f. horsepower
g.	kilogram	a. calorie

5. Please match the measuring instruments on the left with the metric units on the right.

a.	balance scale	a. grams
b.	pressure gauge	b. kilopascals
c.	tape	e. centimetres
d.	container	d. millilitres
e.	ruler	c. hectares

6. A carpet 360 centimetres by 450 centimetres is also:

a. 6 metres x 9 metres
b. 36 metres x 45 metres
(c.) 3.6 metres x 4.5 metres
d. 0.36 metre x 0.45 metre

7. The correct way to write twenty grams is:

a. 20 gms b. 20 Gm. c. 20 g. (d.) 20 g

8. The equivalent of 2 m is about:

a. 4 feet (b) 7 feet c. 24 feet d. 200 feet

9. Estimate the length of the line segment below.

_____

a. 23 grams (b) 6 centimetres c. 40 millimetres d. 14 pascals

10. Fill in the following chart.

millilitres (ml)	litres (l)	millilitres (ml)	litres (l)
3 000	3	700	(0.7)
6 000	(6)	(900)	0.9
(8 000)	8	250	(0.25)
14 000	(14)	(470)	0.47
(23 000)	23	275	(0.275)
300	(0.3)		

11. Use the conversion table to answer the following:

The equivalent of . . .

a. 150 mm is how many inches 5.91
b. 210 mm is how many inches 8.26
c. 990 mm is how many inches 38.97

mm	in.
100	3.94
200	7.87
300	11.81
800	31.50
900	35.43
10	0.39
20	0.79
50	1.97
60	2.36

12. Please match the metric equivalents with the following:

a. 2 m_2
b. 1 m^2
c. 1 kg
d. 1 mg
e. 5 ml
f. 1 cm
g. 1 mm
h. 5 g
i. 10 cm
j. 400 kJ

e. teaspoon
j. energy value of an apple
a. height of a doorway
b. a cardtable top
d. mass of a grain of salt
f. width of a paper clip
g. thickness of a dime
c. mass of Webster's Collegiate Dictionary
i. 4 inches
h. mass of a nickel

13. When ordering material for your lab, what metric units are used for the following items:

a. gasoline litre
b. carpet metre
c. leather clothing articles centimetre
d. block solder gram
e. box of cotton gram

METRIC WORKSHOP EVALUATION

Name_____ School_____ Date_____

We desire to make this training program as meaningful and helpful as we can. We earnestly solicit your evaluation of this workshop and gladly welcome your comments and suggestions. Your comments will guide us in planning future workshops. Please answer the questions below.

1. How would you rate the following:	Excellent	Good	Fair	Poor	Unsatisfactory
a. Organization of the workshop	____	____	____	____	____
b. Adequacy of facilities	____	____	____	____	____
c. Quality of presentations	____	____	____	____	____
d. Adequacy of course materials	____	____	____	____	____
e. Adequacy of hands-on devices	____	____	____	____	____
f. Quality of films	____	____	____	____	____
g. Adequacy of course content to my needs	____	____	____	____	____

2. If any factor is rated "poor" or "unsatisfactory," please provide an explanation.

_____

_____

3. Do you feel the training you received adequately prepared you to teach metric measurement? Yes___ No___

4. Please assess your knowledge of the five units in the metric package developed by the Center for Vocational Education.

Level of Competency . . .	High	Average	Low
a. in working with linear, area, temperature, mass and volume.	____	____	____
b. with metrics in your occupation or program.	____	____	____
c. in metric-metric-equivalents.	____	____	____
d. in selecting and using metric instruments, tools and devices.	____	____	____
e. in working with metric conversion tables, ordering, selling and using products and supplies.	____	____	____

Recommendations for Improving the Workshop

UNIT 1

SUGGESTED TEACHING SEQUENCE

1. These introductory exercises may require two or three teaching periods for all five areas of measurement.
2. Exercises should be followed in the order given to best show the relationship between length, area, and volume.
3. Assemble the metric measuring devices (rules, tapes, scales, thermometers, and measuring containers) and objects to be measured.*
4. Set up the equipment at work stations for use by the whole class or as individualized resource activities.
5. Have the students estimate, measure, and record using Exercises 1 through 5.
6. Present information on notation and make Table 1 available.
7. Follow up with group discussion of activities.

*Other school departments may have devices which can be used. Metric suppliers are listed in the reference section.

OBJECTIVES

The student will demonstrate these skills for the Linear, Area, Volume or Capacity, Mass, and Temperature Exercises, using the metric terms and measurement devices listed here.

SKILLS	EXERCISES				
	Linear (pp. 3 - 4)	Area (pp. 5 - 6)	Volume or Capacity (pp. 7 - 8)	Mass (pp. 9 - 10)	Temperature (p. 11)
1. Recognize and use the unit and its symbol for: 2. Select, use, and read the appropriate measuring instruments for: 3. State or show a physical reference for:	millimetre (mm) centimetre (cm) metre (m)	square centimetre (cm^2) square metre (m^2)	cubic centimetre (cm^3) cubic metre (m^3) litre (l) millilitre (ml)	gram (g) kilogram (kg)	degree Celsius (°C)
4. Estimate within 25% of the actual measure	height, width, or length of objects	the area of a given surface	capacity of containers	the mass of objects in grams and kilograms	the temperature of the air or a liquid
5. Read correctly	metre stick, metric tape measure, and metric rulers		measurements on graduated volume measuring devices	a kilogram scale and a gram scale	A Celsius thermometer

RULES OF NOTATION

1. Symbols are not capitalized unless the unit is a proper name (mm *not* MM).
2. Symbols are not followed by periods (m *not* m.).
3. Symbols are not followed by an *s* for plurals (25 g *not* 25 gs).
4. A space separates the numerals from the unit symbols (4 l *not* 4l).
5. Spaces, not commas, are used to separate large numbers into groups of three digits (45 271 km *not* 45,271 km).
6. A zero precedes the decimal point if the number is less than one (0.52 g *not* .52 g).
7. Litre and metre can be spelled either with an -re or -er ending.

METRIC UNITS, SYMBOLS, AND REFERENTS

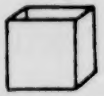
Quantity	Metric Unit	Symbol	Useful Referents
Length	millimetre	mm	Thickness of dime or paper clip wire
	centimetre	cm	Width of paper clip
	metre	m	Height of door about 2 m
	kilometre	km	12-minute walking distance
Area	square centimetre	cm^2	Area of this space
	square metre	m^2	Area of card table top
	hectare	ha	Football field including sidelines and end zones
Volume and Capacity	millilitre	ml	Teaspoon is 5 ml
	litre	l	A little more than 1 quart
	cubic centimetre	cm^3	Volume of this container 
	cubic metre	m^3	A little more than a cubic yard
Mass	milligram	mg	Apple seed about 10 mg, grain of salt, 1 mg
	gram	g	Nickel about 5 g
	kilogram	kg	Webster's Collegiate Dictionary
	metric ton (1 000 kilograms)	t	Volkswagen Beetle

Table 1–a

METRIC PREFIXES

Multiples and Submultiples	Prefixes	Symbols
$1\,000\,000 = 10^6$	mega (mĕg′ə)	M
$1\,000 = 10^3$	kilo (kĭl′ō)	k
$100 = 10^2$	hecto (hĕk′tō)	h
$10 = 10^1$	deka (dĕk′ə)	da
Base Unit $1 = 10^0$		
$0.1 = 10^{-1}$	deci (dĕs′ĭ)	d
$0.01 = 10^{-2}$	centi (sĕn′tĭ)	c
$0.001 = 10^{-3}$	milli (mĭl′ĭ)	m
$0.000\,001 = 10^{-6}$	micro (mī′krō)	μ

Table 1–b

LINEAR MEASUREMENT ACTIVITIES

Metre, Centimetre, Millimetre

I. THE METRE (m)

A. DEVELOP A FEELING FOR THE SIZE OF A METRE

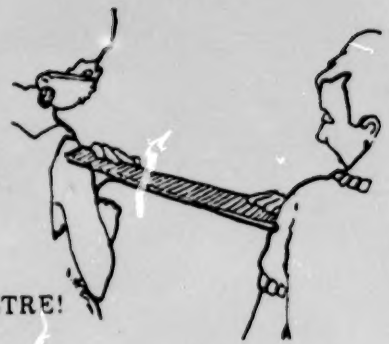
1. Pick up one of the metre sticks and stand it up on the floor. Hold it in place with one hand. Walk around the stick. Now stand next to the stick. With your other hand, touch yourself where the top of the metre stick comes on you.

THAT IS HOW HIGH A METRE IS!

2. Hold one arm out straight at shoulder height. Put the metre stick along this arm until the end hits the end of your fingers. Where is the other end of the metre stick? Touch yourself at that end.

THAT IS HOW LONG A METRE IS!

3. Choose a partner to stand at your side. Move apart so that you can put one end of a metre stick on your partner's shoulder and the other end on your shoulder. Look at the space between you.



THAT IS THE WIDTH OF A METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN METRES

Now you will improve your ability to estimate in metres. Remember where the length and height of a metre was on your body.

For each of the following items:

Estimate the size of the items and write your estimate in the ESTIMATE column. Measure the size with your metre stick and write the answer in the MEASUREMENT column.

Decide how close your estimate was to the actual measure. If your estimate was within 25% of the actual measure you are a "Metric Marvel."

		Estimate (m)	Measurement (m)	How Close Were You?
1.	Height of door knob from floor.	_____	_____	_____
2.	Height of door.	_____	_____	_____
3.	Length of table.	_____	_____	_____
4.	Width of table.	_____	_____	_____
5.	Length of wall of this room.	_____	_____	_____
6.	Distance from you to wall.	_____	_____	_____

(continued on next page)

THE CENTIMETRE (cm)

There are 100 centimetres in one metre. If there are 4 metres and 3 centimetres, you write 403 cm [(4 x 100 cm) + 3 cm = 400 cm + 3 cm].

A. DEVELOP A FEELING FOR THE SIZE OF A CENTIMETRE

1. Hold the metric ruler against the width of your thumbnail. How wide is it? _____ cm
2. Measure your thumb from the first joint to the end. _____ cm
3. Use the metric ruler to find the width of your palm. _____ cm
4. Measure your index or pointing finger. How long is it? _____ cm
5. Measure your wrist with a tape measure. What is the distance around it? _____ cm
6. Use the tape measure to find your waist size. _____ cm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CENTIMETRES

You are now ready to estimate in centimetres. For each of the following items, follow the procedures used for estimating in metres.

	Estimate (cm)	Measurement (cm)	How Close Were You?
1. Length of a paper clip.			
2. Diameter (width) of a coin.			
3. Width of a postage stamp.			
4. Length of a pencil.			
5. Width of a sheet of paper.			

III. THE MILLIMETRE (mm)

There are 10 millimetres in one centimetre. When a measurement is 2 centimetres and 5 millimetres, you write 25 mm [(2 x 10 mm) + 5 mm = 20 mm + 5 mm]. There are 1 000 mm in 1 m.

A. DEVELOP A FEELING FOR THE SIZE OF A MILLIMETRE

Using a ruler marked in millimetres, measure:

1. Thickness of a paper clip wire. _____ mm
2. Thickness of your fingernail. _____ mm
3. Width of your fingernail. _____ mm
4. Diameter (width)of a coin. _____ mm
5. Diameter (thickness) of your pencil. _____ mm
6. Width of a postage stamp. _____ mm

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLIMETRES

You are now ready to estimate in millimetres. For each of the following items, follow the procedures used for estimating in metres.

	Estimate (mm)	Measurement (mm)	How Close Were You?
1. Thickness of a nickel.			
2. Diameter (thickness) of a bolt.			
3. Length of a bolt.			
4. Width of a sheet of paper.			
5. Thickness of a board or desk top.			
6. Thickness of a button.			

AREA MEASUREMENT ACTIVITIES

Square Centimetre, Square Metre

WHEN YOU DESCRIBE THE AREA OF SOMETHING, YOU ARE SAYING HOW MANY SQUARES OF A GIVEN SIZE IT TAKES TO COVER THE SURFACE.

I. THE SQUARE CENTIMETRE (cm^2)

A. DEVELOP A FEELING FOR A SQUARE CENTIMETRE

1. Take a clear plastic grid, or use the grid on page 6.
2. Measure the length and width of one of these small squares with a centimetre ruler.

   THAT IS ONE SQUARE CENTIMETRE!

3. Place your fingernail over the grid. About how many squares does it take to cover your fingernail?
   _____cm^2
4. Place a coin over the grid. About how many squares does it take to cover the coin? _____cm^2
5. Place a postage stamp over the grid. About how many squares does it take to cover the postage stamp?
   _____cm^2
6. Place an envelope over the grid. About how many squares does it take to cover the envelope?
   _____cm^2
7. Measure the length and width of the envelope in centimetres. Length _____ cm; width _____ cm. Multiply to find the area in square centimetres. _____ cm x _____ cm = _____ cm^2. How close are the answers you have in 6. and in 7.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE CENTIMETRES

You are now ready to develop your ability to estimate in square centimetres.

Remember the size of a square centimetre. For each of the following items, follow the procedures used for estimating in metres.

		Estimate (cm^2)	Measurement (cm^2)	How Close Were You?
1.	Index card.	_____	_____	_____
2.	Book cover.	_____	_____	_____
3.	Photograph.	_____	_____	_____
4.	Window pane or desk top.	_____	_____	_____

II. THE SQUARE METRE (m^2)

A. DEVELOP A FEELING FOR A SQUARE METRE

1. Tape four metre sticks together to make a square which is one metre long and one metre wide.
2. Hold the square up with one side on the floor to see how big it is.
3. Place the square on the floor in a corner. Step back and look. See how much floor space it covers.
4. Place the square over a table top or desk to see how much space it covers.
5. Place the square against the bottom of a door. See how much of the door it covers. How many squares would it take to cover the door? _____m^2

   THIS IS HOW BIG A SQUARE METRE IS!

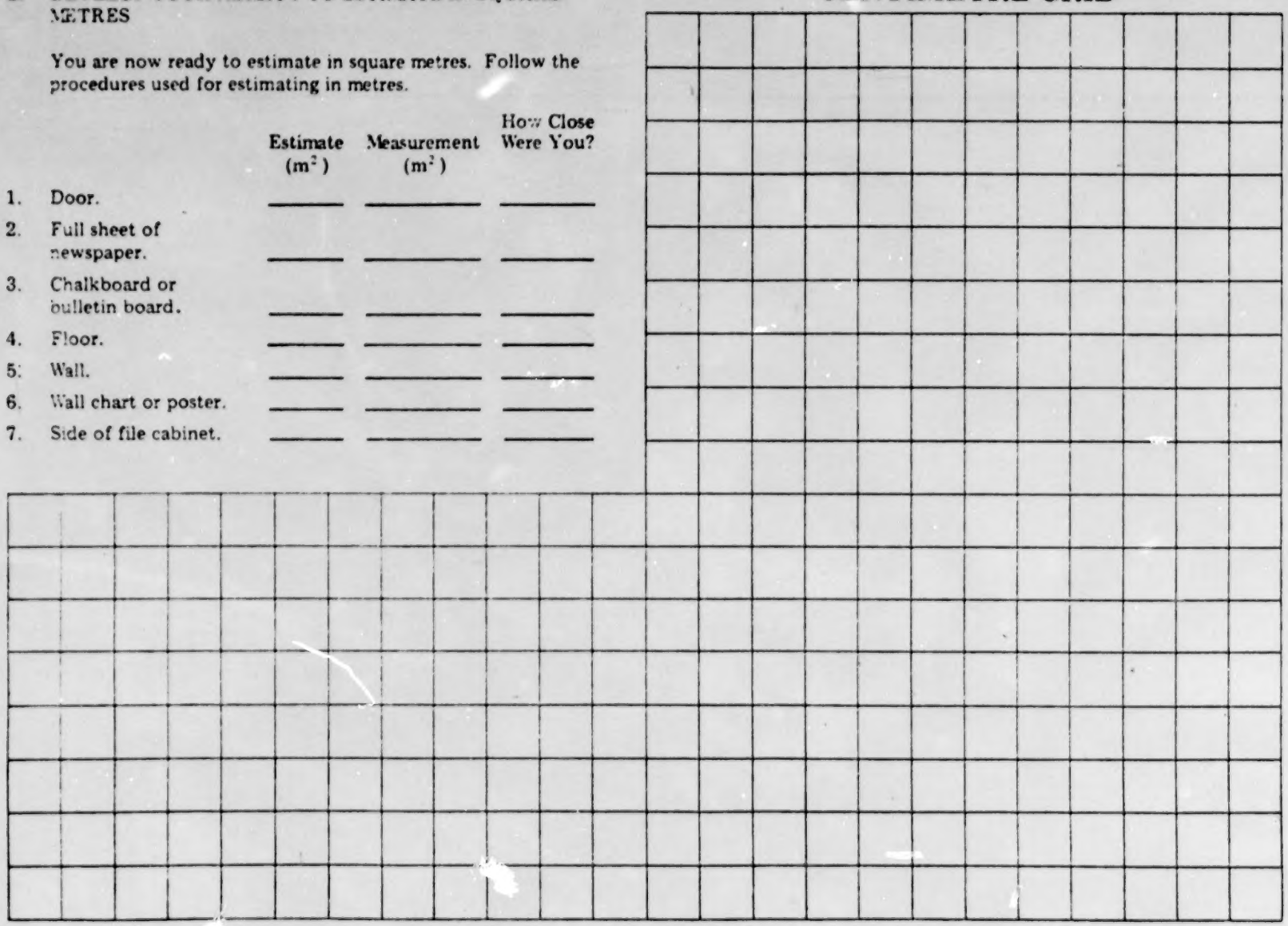
(continued on next page)

B. DEVELOP YOUR ABILITY TO ESTIMATE IN SQUARE METRES

You are now ready to estimate in square metres. Follow the procedures used for estimating in metres.

		Estimate (m^2)	Measurement (m^2)	How Close Were You?
1.	Door.	_____	_____	_____
2.	Full sheet of newspaper.	_____	_____	_____
3.	Chalkboard or bulletin board.	_____	_____	_____
4.	Floor.	_____	_____	_____
5.	Wall.	_____	_____	_____
6.	Wall chart or poster.	_____	_____	_____
7.	Side of file cabinet.	_____	_____	_____

CENTIMETRE GRID



VOLUME MEASUREMENT ACTIVITIES

Cubic Centimetre, Litre, Millilitre, Cubic Metre

I. THE CUBIC CENTIMETRE (cm^3)

A. DEVELOP A FEELING FOR THE CUBIC CENTIMETRE

1. Pick up a colored plastic cube. Measure its length, height, and width in centimetres.

   THAT IS ONE CUBIC CENTIMETRE!

2. Find the volume of a plastic litre box.

   a. Place a ROW of cubes against the bottom of one side of the box. How many cubes fit in the row?_____

   b. Place another ROW of cubes against an adjoining side of the box. How many rows fit inside the box to make one layer of cubes?_____

   How many cubes in each row?_____

   How many cubes in the layer in the bottom of the box?_____

   c. Stand a ROW of cubes up against the side of the box. How many LAYERS would fit in the box?_____

   How many cubes in each layer?_____

   How many cubes fit in the box altogether?_____

   THE VOLUME OF THE BOX IS _____CUBIC CENTIMETRES.

   d. Measure the length, width, and height of the box in centimetres. Length _____cm; width _____cm; height _____cm. Multiply these numbers to find the volume in cubic centimetres.

   _____cm x _____cm x _____cm = _____cm^3.
   Are the answers the same in c. and d.?

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC CENTIMETRES

You are now ready to develop your ability to estimate in cubic centimetres.

Remember the size of a cubic centimetre. For each of the following items, use the procedures for estimating in metres.

		Estimate (cm^3)	Measurement (cm^3)	How Close Were You?
1.	Index card file box.	_____	_____	_____
2.	Freezer container.	_____	_____	_____
3.	Paper clip box.	_____	_____	_____
4.	Box of staples.	_____	_____	_____

II. THE LITRE (l)

A. DEVELOP A FEELING FOR A LITRE

1. Take a one litre beaker and fill it with water.
2. Pour the water into paper cups, filling each as full as you usually do. How many cups do you fill?

   THAT IS HOW MUCH IS IN ONE LITRE!
3. Fill the litre container with rice.

   THAT IS HOW MUCH IT TAKES TO FILL A ONE LITRE CONTAINER!

(continued on next page)

B. DEVELOP YOUR ABILITY TO ESTIMATE IN LITRES

You are now ready to develop your ability to estimate in litres. To write two and one-half litres, you write 2.5 l, or 2.5 litres. To write one-half litre, you write 0.5 l, or 0.5 litre. To write two and three-fourths litres, you write 2.75 l, or 2.75 litres.

For each of the following items, use the procedures for estimating in metres.

		Estimate (l)	Measurement (l)	How Close Were You?
1.	Medium-size freezer container.	_____	_____	_____
2.	Large freezer container.	_____	_____	_____
3.	Small freezer container.	_____	_____	_____
4.	Bottle or jug.	_____	_____	_____

III. THE MILLILITRE (ml)

There are 1 000 millilitres in one litre. 1 000 ml = 1 litre. Half a litre is 500 millilitres, or 0.5 litre = 500 ml.

A. DEVELOP A FEELING FOR A MILLILITRE

1. Examine a centimetre cube. Anything which holds cm^3 holds 1 ml.
2. Fill a 1 millilitre measuring spoon with rice. Empty the spoon into your hand. Carefully pour the rice into a small pile on a sheet of paper.

   THAT IS HOW MUCH ONE MILLILITRE IS!
3. Fill the 5 ml spoon with rice. Pour the rice into another pile on the sheet of paper.

   THAT IS 5 MILLILITRES, OR ONE TEASPOON!
4. Fill the 15 ml spoon with rice. Pour the rice into a third pile on the paper.

   THAT IS 15 MILLILITRES, OR ONE TABLESPOON!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN MILLILITRES

You are now ready to estimate in millilitres. Follow the procedures used for estimating metres.

		Estimate (ml)	Measurement (ml)	How Close Were You?
1.	Small juice can.	_____	_____	_____
2.	Paper cup or tea cup.	_____	_____	_____
3.	Soft drink can.	_____	_____	_____
4.	Bottle.	_____	_____	_____

IV. THE CUBIC METRE (m^3)

A. DEVELOP A FEELING FOR A CUBIC METRE

1. Place a one metre square on the floor next to the wall.
2. Measure a metre UP the wall.
3. Picture a box that would fit into that space.

   THAT IS THE VOLUME OF ONE CUBIC METRE!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN CUBIC METRES

For each of the following items, follow the estimating procedures used before.

		Estimate (m^3)	Measurement (m^3)	How Close Were You?
1.	Office desk.	_____	_____	_____
2.	File cabinet.	_____	_____	_____
3.	Small room.	_____	_____	_____

MASS (WEIGHT) MEASUREMENT ACTIVITIES

Kilogram, Gram

The mass of an object is a measure of the amount of matter in the object. This amount is always the same unless you add or subtract some matter from the object. Weight is the term that most people use when they mean mass. The weight of an object is affected by gravity; the mass of an object is not. For example, the weight of a person on earth might be 120 pounds; that same person's weight on the moon would be 20 pounds. This difference is because the pull of gravity on the moon is less than the pull of gravity on earth. A person's mass on the earth and on the moon would be the same. The metric system does not measure weight--it measures mass. We will use the term mass here.

The symbol for gram is g.

The symbol for kilogram is kg.

There are 1 000 grams in one kilogram, or 1 000 g = 1 kg.

Half a kilogram can be written as 500 g,or 0.5 kg.

A quarter of a kilogram can be written as 250 g,or 0.25 kg.

Two and three-fourths kilograms is written as 2.75 kg.

I. THE KILOGRAM (kg)

DEVELOP A FEELING FOR THE MASS OF A KILOGRAM

Using a balance or scale, find the mass of the items on the table. Before you find the mass, notice how heavy the object "feels" and compare it to the reading on the scale or balance.

		Mass (kg)
1.	1 kilogram box.	_____
2.	Textbook.	_____
3.	Bag of sugar.	_____
4.	Package of paper.	_____
5.	Your own mass.	_____

B. DEVELOP YOUR ABILITY TO ESTIMATE IN KILOGRAMS

For the following items ESTIMATE the mass of the object in kilograms, then use the scale or balance to find the exact mass of the object. Write the exact mass in the MEASUREMENT column. Determine how close your estimate is:

		Estimate (kg)	Measurement (kg)	How Close Were You?
1.	Bag of rice.	_____	_____	_____
2.	Bag of nails.	_____	_____	_____
3.	Large purse or briefcase.	_____	_____	_____
4.	Another person.	_____	_____	_____
5.	A few books.	_____	_____	_____

(continued on next page)

II. THE GRAM (g)

A. DEVELOP A FEELING FOR A GRAM

1. Take a colored plastic cube. Hold it in your hand. Shake the cube in your palm as if shaking dice. Feel the pressure on your hand when the cube is in motion, then when it is not in motion.

   THAT IS HOW HEAVY A GRAM IS!

2. Take a second cube and attach it to the first. Shake the cubes in first one hand and then the other hand; rest the cubes near the tips of your fingers moving your hand up and down.

   THAT IS THE MASS OF TWO GRAMS!

3. Take five cubes in one hand and shake them around.

   THAT IS THE MASS OF FIVE GRAMS!

B. DEVELOP YOUR ABILITY TO ESTIMATE IN GRAMS

You are now ready to improve your ability to estimate in grams. Remember how heavy the 1 gram cube is, how heavy the two gram cubes are, and how heavy the five gram cubes are. For each of the following items, follow the procedures used for estimating in kilograms.

		Estimate (g)	Measurement (g)	How Close Were You?
1.	Two thumbtacks.	_____	_____	_____
2.	Pencil.	_____	_____	_____
3.	Two-page letter and envelope.	_____	_____	_____
4.	Nickel.	_____	_____	_____
5.	Apple.	_____	_____	_____
6.	Package of margarine.	_____	_____	_____

TEMPERATURE MEASUREMENT ACTIVITIES

Degree Celsius

I. DEGREE CELSIUS (°C)

Degree Celsius (°C) is the metric measure for temperature.

A. DEVELOP A FEELING FOR DEGREE CELSIUS

Take a Celsius thermometer. Look at the marks on it.

1. Find 0 degrees.

   WATER FREEZES AT ZERO DEGREES CELSIUS (0°C)

   WATER BOILS AT 100 DEGREES CELSIUS (100°C)

2. Find the temperature of the room. _____°C. Is the room cool, warm, or about right?

3. Put some hot water from the faucet into a container. Find the temperature. _____ °C. Dip your finger quickly in and out of the water. Is the water very hot, hot, or just warm?

4. Put some cold water in a container with a thermometer. Find the temperature. _____ °C. Dip your finger into the water. Is it cool, cold, or very cold?

5. Bend your arm with the inside of your elbow around the bottom of the thermometer. After about three minutes find the temperature. _____ °C. Your skin temperature is not as high as your body temperature.

   NORMAL BODY TEMPERATURE IS 37 DEGREES CELSIUS (37°C).

   A FEVER IS 39°C.

   A VERY HIGH FEVER IS 40°C.

B. DEVELOP YOUR ABILITY TO ESTIMATE IN DEGREES CELSIUS

For each item, ESTIMATE and write down how many degrees Celsius you think it is. Then measure and write the MEASUREMENT. See how close your estimates and actual measurements are.

		Estimate (°C)	Measurement (°C)	How Close Were You?
1.	Mix some hot and cold water in a container. Dip your finger into the water.	_____	_____	_____
2.	Pour out some of the water. Add some hot water. Dip your finger quickly into the water.	_____	_____	_____
3.	Outdoor temperature.	_____	_____	_____
4.	Sunny window sill.	_____	_____	_____
5.	Mix of ice and water.	_____	_____	_____
6.	Temperature at floor.	_____	_____	_____
7.	Temperature at ceiling.	_____	_____	_____

APPENDIX F

PENNSYLVANIA'S VOCATIONAL EDUCATION EXEMPLARY (PART D) METRIC MEASUREMENT PROJECTS FOR 1976-77

PROJECT NUMBER	DATES	INVESTIGATING AGENCY	PROJECT LEADER	FUNDS TOTAL	FUNDS REIMB.	TITLE OF PROJECT
20-6817	10/1/76 9/30/77	Central Westmoreland AVTS (412) 925-3532	Mr. William C. Downs R.D. #1, Arona Road New Stanton, PA 15672	$12,540.13	$12,540.13	"Pilot Metric Program"
20-7001	10/1/76 9/30/77	Lehigh County AVTS (215) 799-2300	Mr. Robert A. Nagle 2300 Main Street Schnecksville, PA 18078	$14,545.00	$11,650.00	"Facilitating Metric Instruction to Teacher and Student Through the Use of Developed Instructional Packages"
20-7002	5/1/77 9/30/77	Millersville State College (717) 872-5411	Miss Erma D. Keyes Millersville, PA 17551	$22,723.00	$20,623.00	"Metrics Training Workshops for Vocational Education"
20-7801	5/30/77 9/39/77	Lancaster County AVTS (717) 464-2771	Mr. Ralph M. Layman 1730 Hans Herr Drive Willow Street, PA 17584	$ 6,878.18	$ 2,665.18	"Teacher In-Service Workshop for Metric Measurement"
20-7802	5/30/77 9/30/77	Centre County AVTS (814) 359-2793	Mr. William L. Springer Pleasant Gap, Pa 16823	$ 4,275.00	$ 450.00	"Teacher In-Service Workshop for Metric Measurement"
20-7803	5/30/77 9/30/77	Clearfield County AVTS (814) 765-5308	Dr. Ivan C. McGee P.O. Box 1028 Clearfield, PA 16830	$ 4,915.00	$ 1,800.00	"Teacher In-Service Workshop for Metric Measurement"
20-7804	5/30/77 9/30/77	School District of Pittsburgh (412) 622-3703	Mr. Robert G. Lamping 341 S. Bellefield Ave. Pittsburgh, PA 15213	$52,098.00	$16,500.00	"Metric In-Service Workshop"
20-7805	5/30/77 9/30/77	North Fayette AVTS (412) 626-0236	Mr. William F. Barry Locust St. Ext. Connellsville, PA 15425	$ 3,825.00	$ 1,500.00	"Teacher In-Service Workshop for Metric Measurement"
20-7806	5/30/77 9/30/77	SUN AVTS (717) 966-1031	Mr. William B. Reiber 815 East Market St. New Berlin, PA 17855	$ 5,366.55	$ 1,500.00	"Teacher Workshop for Metric Measurement"
20-7807	5/30/77 9/30/77	Bethlehem AVTS (215) 866-8013	Mr. Joseph J. Risbon 3300 Chester Avenue Bethlehem, PA 18017	$ 1,600.00	$ 1,500.00	"Teacher In-Service Workshop for Metric Measurement"
20-7808	5/30/77 9/30/77	Juniata-Mifflin County AVTS (717) 248-3933	Mr. James E. Harpster Box 1010 Lewistown, PA 17044	$ 3,175.00	$ 1,650.00	"Teacher In-Service Workshop for Metrics"
20-7809	5/30/77 9/30/77	Bradford County AVTS (717) 365-8111	Mr. John F. Thompson R.D. #1 Towanda, PA 18848	$ 3,046.76	$ 1,626.76	"Teacher In-Service Workshop for Metric Measurement"

20-7810	5/30/77 9/30/77	Erie County AVTS (814) 455-2632	Mr. Richard P. DeLuca 8500 Oliver Road Erie, PA 16509	$ 7,575.00	$ 1,500.00	"Teacher In-Service Workshop for Metric Measurement"
20-7811	5/30/77 9/30/77	North Montco AVTS (215) 368-1177	Mr. Edward V. Tapp Sumneytown Pike Lansdale, PA 19446	$ 3,610.00	$ 2,100.00	"Metric In-Service"
20-7812	5/30/77	West Side AVTS (717) 288-8493	Mr. Thomas F. Feeney Pringle Borough Kingston, PA 18704	$ 2,400.00	$ 1,500.00	"Metric Measurement Workshop"
20-7814	5/30/77 9/30/77	Reading-Muhlenberg AVTS (215) 921-0236	Mr. Charles H. Matters P.O. Box 3068 Reading, PA 19604	$ 8,050.00	$ 2,100.00	"Teacher In-Service Metric Measurement Workshop"
20-7815	5/30/77 9/30/77	Carbon County AVTS (717) 325-3682	Mr. Paul D. Barry 13th Street Jim Thorpe, PA 18229	$ 1,615.00	$ 1,500.00	"Teacher In-Service Workshop for Metric Measurement"
20-7816	7/01/77 9/30/77	Mercer County AVTS (412) 662-3000	Mr. Robert G. Brown P.O. Box 152 Mercer, PA 16137	$ 4,066.80	$ 1,476.80	"Teacher In-Service Workshop for Metric Measurement"
20-7817	5/30/77 9/30/77	Lawrence County AVTS (412) 658-3581	Mr. Fred R. Rockage 750 Wood Street New Castle, PA 16101	$ 2,145.00	$ 2,100.00	"Teacher In-Service Workshop for Metric Measurement"
20-7818	5/30/77 9/30/77	Parkway West AVTS (412) 923-1412	Mr. John C. Garlick R.D. #1, Box 421 Oakdale, PA 15071	$ 7,831.00	$ 1,500.00	"Teacher In-Service Workshop for Metric Measurement"
20-7819	8/05/77 9/30/77	Delaware County I.U. #25 (215) 565-4880	Mr. Merrill I. Hughes State Building Sixth & Olive Sts. Media, PA 19063	$ 4,232.00	$ 4,232.00	"Metric Measurement Package"
20-7820	5/30/77 9/30/77	Crawford County AVTS (814) 724-6024	Mr. Donald H. Dickey 860 Thurston Road Meadville, PA 16335	$ 3,345.00	$ 1,500.00	"Teacher In-Service Workshop - Metric Measure"
20-7821	5/30/77 9/30/77	Monroe County AVTS (717) 629-2001	Mr. Alan K. Cohen P.O. Box 66 Bartonsville, PA 18321	$ 5,850.00	$ 1,650.00	"Metric In-Service Workshop"
20-7822	5/30/77 9/30/88	Wilkes-Barre AVTS (717) 822-4131	Mr. Robert F. Jones R.D. #2, Jumper Road P.O. Box 1699 North End Station Wilkes-Barre, PA 18705	$ 2,207.80	$ 1,877.80	"Teacher In-Service Workshop for Metric Measurement"
20-7823	5/30/77 9/30/77	Tioga County AVTS (717) 724-3771	Dr. Robert S. Barr R.D. #2, Box 290A Wellsboro, PA 15901	$ 1,820.00	$ 1,500.00	"Metric Workshop"

20-7824	5/30/77 9/30/77	Williamsport Area Community College (717) 326-3761	Mr. Alfred L. Hauser 1005 West 3rd Street Williamsport, PA 17701	$ 2,001.38	$ 1,000.00	"In-Service Program for Metric Measure"
20-7825	5/30/77 9/30/77	Lebanon County AVTS (717) 273-8551	Mr. Earl L. Horst 833 Metro Drive Lebanon, PA 17042	$ 1,489.25	$ 1,489.25	"Development of Metric Instructional Program"
20-7826	5/30/77 9/30/77	Central Montgomery County AVTS (215) 277-2301	Mr. John G. Williams New Hope St. & Plymouth Road Norristown, PA 19401	$ 1.710.00	$ 1,500.00	"Metric In-Service"
20-7827	5/30/77 9/30/77	Forbes Road East AVTS (412) 373-8100	Mr. George L. Lange Beatty and Cooper Rds. Monroeville, PA 15146	$ 8,700.00	$ 1,500.00	"Teacher In-Service Workshop fo Metric Measurement"

PENNSYLVANIA'S VOCATIONAL EDUCATION EXEMPLARY (PART D) METRIC MEASUREMENT PROJECTS FOR 1977-78

PROJECT NUMBER	DATES	INVESTIGATING AGENCY	PROJECT LEADER	FUNDS TOTAL	FUNDS REIMB.	TITLE OF PROJECT
20-7829	11/1/77 6/30/78	Bucks County AVTS (215) 949-1700	Mr. Walter J. Wronoski Wistar Road Fairless Hills, PA 19030	$ 1,006.55	$ 1,006.50	"Metrics Instruction"
20-7831	10/1/77 6/30/78	Lackawanna Co. AVTS (717) 346-8471	Mr. Robert D. Muzzi 3201 Rockwell Avenue Scranton, PA 18508	$ 6,948.64	$ 2,750.64	"Teacher In-Service for Metric Workshop"
20-7832	10/1/77 6/30/78	Schuylkill Co. AVTS (717) 622-3350	Mr. Ray L. Taylor 420 North Centre St. Pottsville, PA 17901	$ 9,770.00	$ 9,770.00	"Teacher In-Service Metric Measurement Workshop"

PENNSYLVANIA'S VOCATIONAL EDUCATION EXEMPLARY (PART D) METRIC MEASUREMENT PROJECTS FOR 1978-79

PROJECT NUMBER	DATES	INVESTIGATING AGENCY	PROJECT LEADER	FUNDS TOTAL	FUNDS REIMB.	TITLE OF PROJECT
84-8801	7/1/78 6/30/79	Lehigh County AVTS (215) 799-1322	Mr. Robert A. Nagle 2300 Main Street Schnecksville, PA	$12,470.00	$12,470.00	"Metric Measurement Workshop for Vocational Facilitators"
84-8802	7/1/78 6/30/79	Central Westmoreland AVTS (412) 925-3532	Mr. William C. Downs R.D. #1, Arona Road New Stanton, PA 15672	$12,419.00	$12,419.00	"Metric Measurement Workshop for Vocational Facilitators"

84-8803	7/1/78 6/30/79	Steel Valley AVTS (412) 461-8373	Mr. Frank Sanns 4920 Buttermilk Road West Mifflin, PA 15122	$ 6,415.72	$ 1,900.00	"RCU Metric Measurement Program"
84-8804	7/1/78 6/30/79	Huntingdon Co. AVTS (814) 643-0951	Mr. Robert W. Rowland Box E Mill Creek, PA 17060	$ 3,713.92	$ 2,000.00	"Metric Measurement Workshop"
84-8805	7/1/78 6/30/79	Greene County AVTS (412) 627-3106	Mr. Norman W. Waldman R.D. #2, Box 40 Waynesburg, PA 15370	$ 3,212.62	$ 2,200.00	"Teacher In-Service Workshop for Metric Measurement"
84-8806	7/1/78 6/30/79	McKeesport AVTS (412) 672-9161	Mr. George Balog 3600 O'Neil Blvd. McKeesport, PA 15132	$ 5,192.00	$ 2,000.00	"Teacher In-Service Workshop for Metric Measurement"
84-8807	7/1/78 6/30/79	Carlisle Area School District (717) 243-5353	Mr. James J. Barefoot 623 West Penn Street Carlisle, PA 17013	$ 2,750.00	$ 1,950.00	"Teacher In-Service Workshop for Metric Measurement"
84-8808	7/1/78 6/30/79	Harrisburg-Steelton-Highspire AVTS (717) 234-2611	Ms. Juanita D. Moore 2915 N. 3rd Street Harrisburg, PA 17110	$ 5,550.00	$ 1,800.00	"Teacher In-Service Workshop for Metric Measurement"
84-8809	7/1/78 6/30/79	Butler Area School District (412) 287-8721 Ext. 250	Mr. Walter Timm 167 New Castle Road Butler, PA 16001	$ 5,775.00	$ 1,725.00	"Teacher In-Service Workshop for Metric Measurement"
84-8810	7/1/78 6/30/79	Venango County AVTS (814) 646-1267	Mr. William H. Clark, Jr. 1 Vo-Tech Drive Oil City, PA 16301	$ 6,495.28	$ 2,300.00	"Teacher In-Service Workshop for Metric Measurement"
84-8811	7/1/78 6/30/79	Lenape AVTS (412) 763-7116	Mr. Edwin O. Riebel 2215 Chaplin Avenue Ford City, PA 16226	$ 4,850.00	$ 1,850.00	"Teacher In-Service Workshop for Metric Measurement"
84-8812	7/1/78 6/30/79	Tyrone Area School District (814) 684-0710	Mr. Robert E. Westley 1317 Lincoln Avenue Tyrone, PA 16686	$ 7,640.00	$ 1,420.00	"Teacher In-Service Workshop for Metric Measurement"
84-8814	9/1/78 6/30/79	Altoona AVTS (814) 943-5231	Mr. Daniel A. Clark 1500 Fourth Avenue Altoona, PA 16603	$ 1,760.30	$ 1,759.10	"Metrics Measurement Program"
84-8817	7/1/78 6/30/79	Jefferson County-DuBois AVTS (814) 653-8265	Mr. Homer L. Horton Reynoldsville, PA 15851	$ 6,080.00	$ 2,000.00	"Teacher In-Service Workshop for Metric Measurement"
84-8821	7/1/78 6/30/79	Seneca Highlands AVTS (814) 887-5512	Mr. Robert P. Stromberg 119 Mechanic Street Smethport, PA 16749	$ 2,175.00	$ 1,215.00	"Teacher In-Service Workshop for Metric Measurement"
	12/7/78 6/30/79	Indiana University of Pennsylvania (412) 357-3054	Dr. Judith L. Cope Uhler Hall Indiana, PA 15705	$ 4,985.00	$ 4,985.00	"Metric Education for State Correctional Institutions and Youth Development Centers"
	11/1/78 6/30/79	Upper Bucks AVTS (215) 795-2911	Mr. Joseph J. Vallone R.R. #2, Box 207 Perkasie, PA 18944	$ 800.00	$ 800.00	"Teacher Inservice Workshop for Metric Measurement"

JPL/cm6

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$ 50 to $100 the discount is	5%
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Appendix G

INFORMATION
LESSON PLAN

LESSON TITLE: An Introduction to the Metric System

COURSE: Drafting

LESSON OBJECTIVES: The student should be able to:

1. Identify the Metric System as a Decimal System with the metre as the basic unit.
2. State that there are only 7 units in Metric System.
3. Recognize the Metric System VS the Customary (English).

TIME ALLOWED: 20 minutes

EQUIPMENT AIDS:

1. Projector
2. Transparencies
3. Yard stick
4. Extension for showing extra length of metre VS yard stick

REFERENCES:

1. "Drafting Tech. and Practice" - Spence
2. "Mechanical Drawing" - French and Svenson
3. "Drafting and Graphics" - Giachino and Beukema

INTRODUCTION:

The Metric System is coming.

It can't be done in a short time and we must start and prepare for it's inception.

The Metric System works in "Powers of 10" and should be easier to manage when it's gotten into use.

Objectives as stated above

Metric conversions won't happen overnight. Plans indicate that it must be planned over about a 10 year period in order to get it into use.

Fewer than 40% of Americans have even the faintest idea what the Metric System is

BODY: The Metric System is a Decimal System and metre is the basic unit.

In the "Customary System" the basic units are the inch, foot, yard, etc. which break down into fractions and decimals, i.e.; 1/4 = 250, 3/16 = .1875, etc

In the Metric System the basic unit is the "Metre" which originally was defined as "one ten millionth of the distance between the North Pole and the Equator". This in 18th century by a Frenchman named Gabriel Mouton

The French Academy chose the word "Metre", meaning measure, to indicate this unit.

Most countries are now Metric. The U.S. and England were holdouts and now it's just U.S.

BODY: (cont.)

Many industries in the U.S. have been in Metrics for some time - i.e.; Chemical, Optometry, Pharmaceutical, Photography, Cigarette Industry, Track Records, Space Industry, Electronics, also the Medical Profession.

Some companies are Caterpiller, John Deere, RCA, Westinghouse, most large farm machinery manufacturers. Most use a dual dimensioning system which uses both inch and Metric Systems together.

We will be chiefly concerned with measurement and when we start using Metric we will also use the dual system as I'm sure many will do for quite some time to come.

Here is a chart showing the Customary VS the Metric for linear measurement.

Use transparency.

Compare the enlarged graph using Decimal figures.

Refer to systems as shown below.

Show ordinary yard stick with extension piece to indicate the Metre.

Touch on 7 basic units in the Metric System.

SUMMARY:

Metric won't happen overnight.

Metric is a Decimal System with Metre as basic unit.

Many industries already in Metrics.

Restate 7 basic Metric units.

INFORMATION
LESSON PLAN

LESSON TITLE: Caiculating Area Measurement

COURSE: The Metric System

TOPIC: Square Centimeter (CM^2)

FACILITIES: Classroom

TIME ALLOWED: 15 minutes

EQUIPMENT AIDS:
1. Chalkboard and chalk
2. Metric Rulers - Metric Sticks
3. Activity Books

TEACHER PREPARATION: Study Handout Booklet - (Teaching and Learning the Metric System).

MATERIALS: Student must bring to class:

1. Activity Book
2. Pencil
3. Metric stick or ruler

LESSON OBJECTIVES: As a result of this lesson, the student will calculate a designated surface area to the nearest square centimeter.

MOTIVATION STATEMENT: All industrialized nations are now committed to metrication making it absolutely necessary for all to know and understand metric measurements.

PRESENTATION:
1. The instructor will use the chalkboard to demonstrate the correct method to calculate the square centimeter of a given area.
2. Review markings on the meter stick.
3. Explain while marking off area on chalkboard.
4. Instruct students to measure their activity book and calculate its area using the metric tape. Have them write the square centimeter figures on a paper.
5. Check students' measurements.

EVALUATION: The students will use a metric tape to measure their activity book and write the figures on a piece of paper. The measurements must be accurate and written as square centimeter.

$$\begin{array}{r} 29.5 \text{ CM} \\ \times \quad 21 \\ \hline 295 \\ 590 \\ \hline 61.95 \quad CM^2 \end{array}$$

WILKES-BARRE AREA VOCATIONAL-TECHNICAL SCHOOL

LESSON PLAN

Program Area Practical Nursing

UNIT: Obstetrics

LESSON TOPIC: Cervical Dilatation

OBJECTIVE: To show how the metric system is utilized in obstetrical nursing

INTRODUCTION: 2.5 cm = 1 inch 10 cm = Full dilatation (4 inches)

Full dilatation of the cervix is necessary for delivery of the baby.

METHOD: Vaginal examination by the physician.

LEARNING ACTIVITIES: Observing the patient in labor.

RESOURSES: Obstetric Textbook
Charts & Posters

EVALUATION: The head nurse and the physician evaluate the labor patients' progress by vaginal examination; then advises the bedside nurse of this and gives instructions for coaching the patient through each stage of labor.

SUMMARY: The practical nurse administers emotional support to the laboring patient just by staying with her and coaching her during the three stages of labor to and including delivery of the baby.

Appendix H
Metric Measurement Survey

SCHOOL SUN Area Vocational-Technical School

1. Number of teachers in your school. 22
2. Number of teachers inserviced on metric measurement. 2 + 6 staff
3. Number of students in vocational programs. 780
4. Number of students that received metric measurement instruction. 386
5. Number of students taking the appropriate "testing metric abilities" (located in the back section of each metric booklet) and the number that successfully answered at least 80 percent of the questions on each test.

Name of Booklet	Number Taking the Test	Number Successfully Answering at Least 80% of the Questions
Metrics for Welding and Cutting	8	5
Metrics for Architectural, Civil and Mechanical Drafting	13	13
Metrics for Blueprint Reading	17	10
Metrics for Air Conditioning and Refrigeration, Heating and Ventilating	16	9
Metrics for Litho Photography, Offset Stripping and Offset Platemaking	18	8
Metrics for Dental Assistant	15	13
Metrics for Auto Mechanics	17	10
Metrics for Industrial Electronics, Radio/TV Repair, Audio Equipment Repair	18	15
Metrics for Diesel Mechanics	19	8
Metrics for Cosmetologists	15	9
Metrics for Agricultural Supplies and Service	17	10
Metrics for Key Punch Operators	20	17
Metrics for Commercial, Industrial, Residential Electricity	16	9
Metrics for Alterations Specialists and Tailoring	14	8
Since booklets were not available for certain fields, a comparative test comprising parts of related workbook tests were developed for the students.	37	29
Many students received instruction but, unfortunately, their test scores do not reflect an accurate comparison between the prepared workbook tests or the ones developed by combining related field tests. The test contained 35 questions with the overall average at 27.8 questions answered correctly.	126	
TOTAL STUDENTS RECEIVING INSTRUCTION	386	173